

## Claims

- [c1] Claim 1. A method for manufacturing a photomask, comprising steps of:  
forming an opaque layer; and  
etching the opaque layer by using a gas mixture having a selectivity of about 1.2:1 between the opaque layer and the resist layer.
- [c2] Claim 2. The method of claim 1, wherein the gas mixture comprises  $\text{Cl}_2$ , He,  $\text{O}_2$  and  $\text{CO}_2$ .
- [c3] Claim 3. The method of claim 2, wherein a ratio of gas mixture among  $\text{Cl}_2$ , He,  $\text{O}_2$  and  $\text{CO}_2$  is 4:1:1:2.5.
- [c4] Claim 4. The method of claim 3, wherein the gas mixture ratio in volume is about 60% for  $\text{Cl}_2$ , 9% for He, 6% for  $\text{O}_2$  and 25% for  $\text{CO}_2$ .
- [c5] Claim 5. The method of claim 1, wherein the opaque layer is Cr, a Cr compound, a Mo alloy or W.
- [c6] Claim 6. The method of claim 1, wherein the CD (critical dimension) uniformity, 3-sigma, for manufacturing a photomask is 10 nm or less.

- [c7] Claim 7. The method of claim 1, wherein the resist layer is a CAR (chemically amplified resist) or e-beam resist or laser (optical) type resist.
- [c8] Claim 8. The method of claim 1, wherein the etch conditions include between about a ratio of 40 for  $O_2$  and 10 for  $CO_2$  and 10 for  $O_2$  and 40 for  $CO_2$ .
- [c9] Claim 9. The method of claim 8, wherein the etch conditions are in a ratio of about 50 for  $CO_2$  and 20 for  $O_2$ .
- [c10] Claim 10. The method of claim 1, wherein the etch conditions include between about a ratio of 40 for  $O_2$  and 10 for  $CO_2$  and 10 for  $O_2$  and 40  $CO_2$  for a providing CD uniformity in 3-sigma of less than 10 nm and in range of about 20 nm or less.
- [c11] Claim 11. The method of claim 1, wherein the etch conditions include a ratio of about 40 for  $O_2$  and 10 for  $CO_2$  for a providing CD uniformity in 3-sigma of less than 10 nm.
- [c12] Claim 12. The method of claim 1, wherein the gas mixture comprises  $Cl_2$ , He,  $O_2$  and  $CO_2$  with a gas mixture ratio in volume of about 60% for  $Cl_2$ , 9% for He, 6% for  $O_2$  and 25% for  $CO_2$ .
- [c13] Claim 13. The method of claim 1, wherein the etch con-

ditions include a ratio of about 10 for  $O_2$  and 40 for  $CO_2$  for a selectivity Cr:Resist of 1.2:1.

- [c14] Claim 14. The method of claim 1, wherein the opaque layer is Cr, and a Cr rate is about 4.47 Å/sec. and the resist rate is about 3.71 Å/sec.
- [c15] Claim 15. A method for manufacturing a photomask, comprising etching an opaque layer by using a gas mixture of  $Cl_2$ , He,  $O_2$  and  $CO_2$  with etch conditions between about a ratio of 40 for  $O_2$  and 10 for  $CO_2$  and 10 for  $O_2$  and 40 for  $CO_2$ , wherein the etch conditions provide a zero iteration mask fabrication.
- [c16] Claim 16. The method of claim 15, wherein the etch conditions provide a selectivity of Cr:Resist of about or less than 1:1.
- [c17] Claim 17. The method of claim 15, wherein the etch conditions provide CD uniformity in 3-sigma of less than 10 nm and in range of about 20 nm or less.
- [c18] Claim 18. The method of claim 15, wherein the etch conditions include a ratio of about 40 for  $O_2$  and 10 for  $CO_2$  for a providing CD uniformity in 3-sigma of less than 10 nm.
- [c19] Claim 19. The method of claim 15, wherein the gas mix-

ture comprises  $\text{Cl}_2$ , He,  $\text{O}_2$  and  $\text{CO}_2$  with a gas mixture ratio in volume of about 60% for  $\text{Cl}_2$ , 9% for He, 6% for  $\text{O}_2$  and 25% for  $\text{CO}_2$ .

[c20] Claim 20. The method of claim 15, wherein a gas ratio of  $\text{Cl}_2$ , He,  $\text{O}_2$  and  $\text{CO}_2$  is 4:1:1:2.5, wherein the opaque layer is Cr, a Cr compound, a Mo alloy or W.

[c21] Claim 21. A photomask comprising a substrate and an opaque layer selectively formed on the substrate, the mask manufactured by steps comprising etching the opaque layer with either a chlorine or fluorine containing species and a gas mixture of  $\text{O}_2$  and  $\text{CO}_2$  having a selectivity lower than 1:1 between the opaque layer and the resist layer.

[c22] Claim 22. The photomask of claim 21, wherein the gas mixture is  $\text{Cl}_2$ , He,  $\text{O}_2$  and  $\text{CO}_2$ .

[c23] Claim 23. The photomask of claim 21, wherein a ratio of gas mixture among  $\text{Cl}_2$ , He,  $\text{O}_2$  and  $\text{CO}_2$  is 4:1:1:2.5 and the gas mixture ratio in volume is 60% for  $\text{Cl}_2$ , 8.7% for He, 6.2% for  $\text{O}_2$  and 25% for  $\text{CO}_2$ .

[c24] Claim 24. The photomask of claim 21, wherein the opaque layer is Cr, a Cr compound, a Mo alloy or W.

- [c25] Claim 25. The photomask of claim 21, wherein the CD (critical dimension) uniformity, three sigma, for manufacturing the photomask is less than 10 nm.
- [c26] Claim 26. The photomask of claim 21, wherein the resist layer is a CAR (chemically amplified resist) or e-beam resist or laser (optical) type resist.
- [c27] Claim 27. The photomask of claim 21, further comprising a reflection prevention layer formed on the opaque layer, wherein  
the substrate is a transparent material and the reflection prevention layer is an oxide of the opaque layer.